Improving Access to Water Information: NWIS Web Services Snapshot for ArcGIS

Sally Holl

USGS Texas Water Science Center

Austin, Texas

http://txpub.usgs.gov/snapshot

U.S. Department of the Interior
U.S. Geological Survey

USGS Texas Water Science Center Technical Talk– Nov. 1, 2012

Outline

- Objectives
- Overview: NWIS & NWISWeb
- The Challenge
- The Solution
- Use Cases
- The Future
- Where to get the software and source code

“A wonderfully useful USGS tool”

THE CHANNEL RESTORATIONIST

Information and tools for those involved with stream and river restoration

« Free AGU Geophysical Monograph on Stream Restoration

Making volunteer monitoring data available to a larger audience »

Wonderfully useful USGS tool

July 30, 2012 by Bill McDavitt

Since about 1997 or so, I’ve been looking at USGS daily flow data. I also started using ESRI’s GIS software around that time as well. Despite being released last December, I just found out about this tool only a few days ago. Now that I’ve given it a spin, I am very impressed. ESRI’s latest version of ArcGIS (version 10) and the USGS NWIS Snapshot tool are perfect companions.

Here’s a link to the 2 page summary of the USGS tool: http://pubs.usgs.gov/fs/2011/3141/

“The Snapshot tool is one of the easiest to learn tools that I’ve seen…”

- Ipswich Community Watershed Volunteer, 7-30-2012

USGS
science for a changing world

http://www.usgs.gov/

Start with Science

Maps, Imagery, and Publications | Hazards | Newsroom | Education | Jobs | Partnerships | Library | About USGS | Social Media

How do we make smart decisions about a changing world?

Start with Science

There are 7 billion people on Earth, and that number is increasing every day — human influence on our planet is ever more apparent. Changes to the natural world combined with growing human demands threaten our health and safety, our national security, our economy and our quality of life.

Help shape the future of USGS science!

Offer your comments on our draft strategies.

The USGS is focused on some of the most significant issues society faces, in which natural science can make a substantial contribution to the well-being of the Nation and the world. The USGS Science Strategy outlines the major societal issues that USGS science is poised to address. Now we're creating specific strategies for each of those areas to expand and advance the actions we can take in the next decade, and we need your help. SHARE

- Core Science Systems
- Climate and Land Use Change
- Energy and Minerals
- Environmental Health
- Ecosystems
- Natural Hazards
- Water

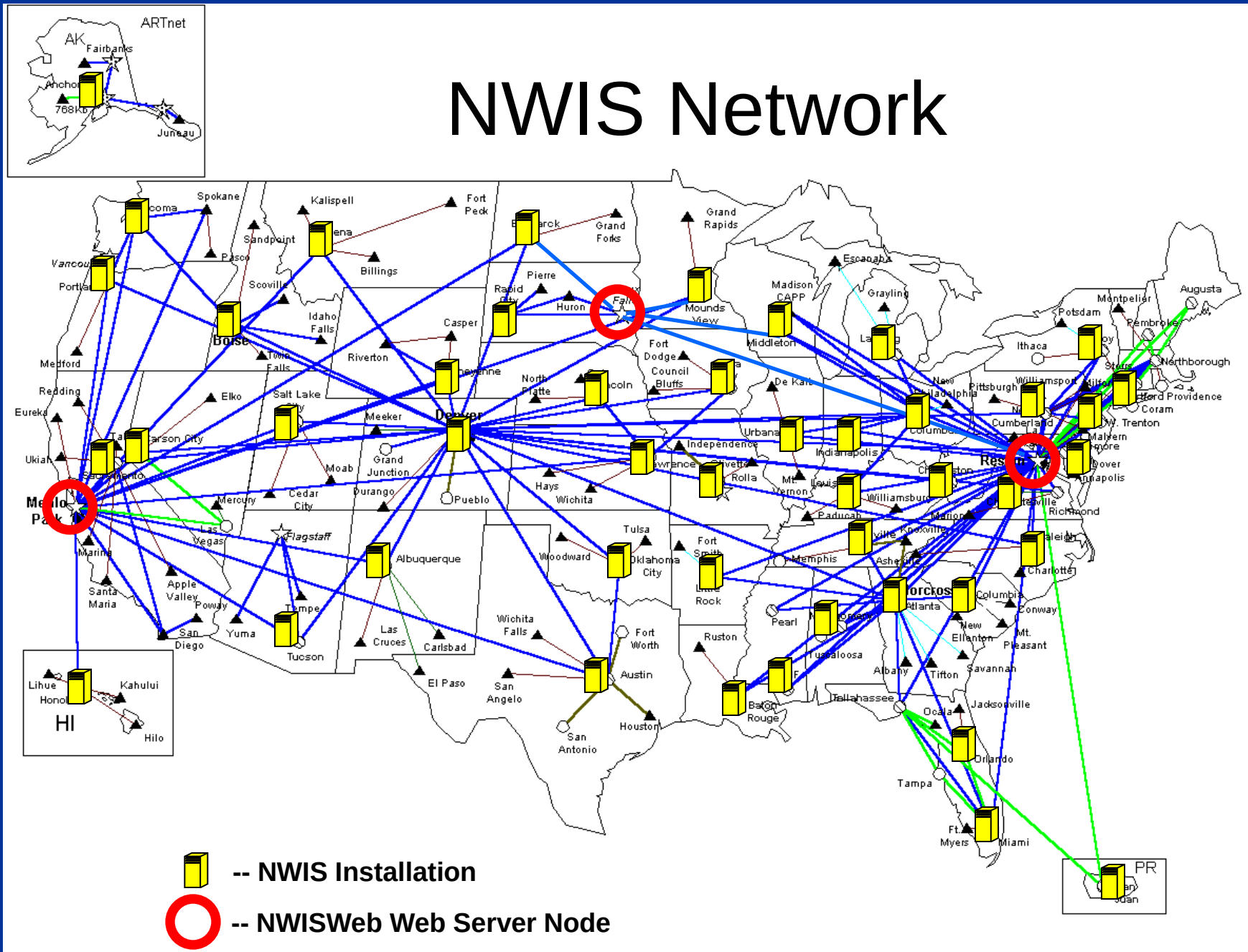
USGS Community for Data Integration

- A dynamic community of practice working together to advance scientific data and information management and integration capabilities in the USGS
- *https://my.usgs.gov/confluence/display/cdi/*
- Working groups
  - Citizen Science, Data Management, Semantic Web, Mobile Applications, Cloud Computing, + more

National Water Information System (NWIS)

- Ground-Water Site-Inventory System (GWSI)
- Automated Data Processing System (ADAPS) (time series database)
- Water-Quality System (QWDATA)
- Water Use Subsystems (SWUDS, AWUDS)
- Device Conversion and Delivery System (DECODES)
- Project Networks

NWIS Network

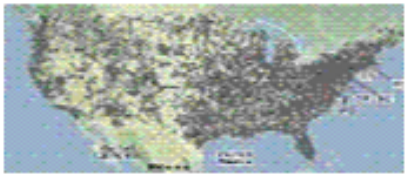


USGS Water Data for the Nation

Search for Sites With Data

Current Conditions Sites with real-time or recent surface-water, groundwater, or water-quality data.

Site Information Descriptive site information for all sites with links to all available water data for individual sites.



Map of all sites with links to all available water data for individual sites.

Frequent Searches By Data Category

Surface Water Water flow and levels in streams and lakes.

Groundwater Water levels in wells.

Water Quality Chemical and physical data for streams, lakes, springs, wells and other sites.

Internal Access Only See this section.

[NWIS

Questio
Feedbac
Automa
Help

National Water Information System (NWIS):
The "**gold standard**" for water information
http://waterdata.usgs.gov/

NWISWeb – What is it?

- Provides access to select USGS data
  - Real-time data
  - Site information
  - Current and historical
    - Streamflow
      - Daily means
      - Daily, monthly, and annual statistics
      - Peak flows
      - Field Measurements including channel geometry
    - Ground-water levels
    - Water-quality
- Does not include all data stored in NWIS

http://waterdata.usgs.gov/

What is *not* included in NWISWeb?

USGS 11455760 SUIS
STATION

Availabl

Stream Site

DESCRIPTION:

Latitude 38°03'52", Longitu
Solano County, California, Hydrologic Unit 18050001
Datum of gage: 0. feet above sea level NGVD29.

AVAILABLE DATA:

*****There are no data available online for this site.*****

Contact the state office (below) to inquire about the availability of other data for this site.

OPERATION:

Record for this site is maintained by the USGS California Water Science Center
Email questions about this site to California Water Science Center Water-Data Inquiries

USGS Water Data for the Nation (NWISWeb) Database

	Sites	Values
Total	1,555,979	Bazillions
Instantaneous values	12,846	358,000,000
Daily values	35,010	325,000,000
Ground-water levels	840,535	8,660,000
Water Quality samples	381,917	5,024,000
Water Quality values	381,917	94,251,000
Peaks	27,943	720,000

From David Briar, August 2011

The Cl ality

Downloading and Preprocessing NWIS Water Quality Data
Working Notes from North Dakota Example
March 2009

. http://nwis.waterdata.usgs.gov/usa/nwis/nwis - Home page is only place with "Help" button that explains codes and parameters (fields with numbers) – sort of – really weak.

2. Go to Water Quality, select state in upper right corner and hit go – gives you count of available data for that state after each tab.

3. Choose "Field/Lab Samples. Takes you t... the query by location, id, attribute, data – no way to just pull data by state unless you submit ...still have to get those from Lat-Long box or something.

4. Since chemistry tables are large, I had ...d to submit all sites for state). Used Lat-Long option to do thi...

5. Middle section of page pertains only ...-" button at the bottom of page to download t...

Choose Output Format
Display Summary of Selected S...
Choose one of the following or... criteria above:

- Table of sites sorted by ...
- Scroll list of sites -- a...
- Brief descriptions --

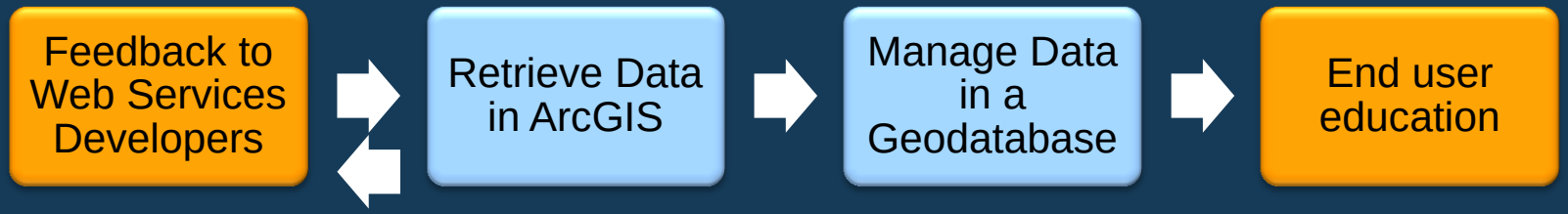
- Inventory of water-quality data — For printing
- Tab-separated inventory of water-quality data — Save to file
- Tab-separated data — One result per row — Default attri...

7. Use Access to preprocess ascii data dumped from NWIS.
   - Used Textpad to cut headers from ascii files
   - Open blank database, Tables, Import, select tab file, next to specify using first row as headers, then hit "Advanced" button on bottom left. Make sure "Site_no" is a text field since it's the primary link/key, chec... other field types and set accordingly.
   - Go to Queries – select "New – Design View" and add appropriate table.
   - Can use New query – Find Duplicates – to make a table of desired parameter values (LUT)
   - Add fields to bottom area, use expressions to change headings in top area, and criteria to select specific values. Link the LUT to limit file to the desired params.
   - Go to top Query menu (which only shows up in design view) and select Crosstab Query.
   - Hit the Summation icon to get Total row to show up (need to Group field)
   - Add expression to replace qualified values:
     VALUE: Max(IIf([remark_cd]="M",-999,IIf([remark_cd]="E",-888,IIf([remark_cd]="<",[result_va]*-1,IIf([remark_cd]=">",-777,[result_va])))))
   - In Crosstab row – fields that you want as column headings --- put as Row Heading, Column Heading = PCODE, and Value is the value field.
   - To save to a table, have to start a new "Make File" query. Add crosstabl qry to this query, pull all fields down by dragging the "*", then hit the red exclamation on top tool bar to make a new table.
   - BEST JUST TO OPEN MY Access db for ND to see examples.
     C:\DATA\MGoldhaber\NWISWeb_ND_March09\ND_WtrQual_NWIS_Access.mdb

USGS

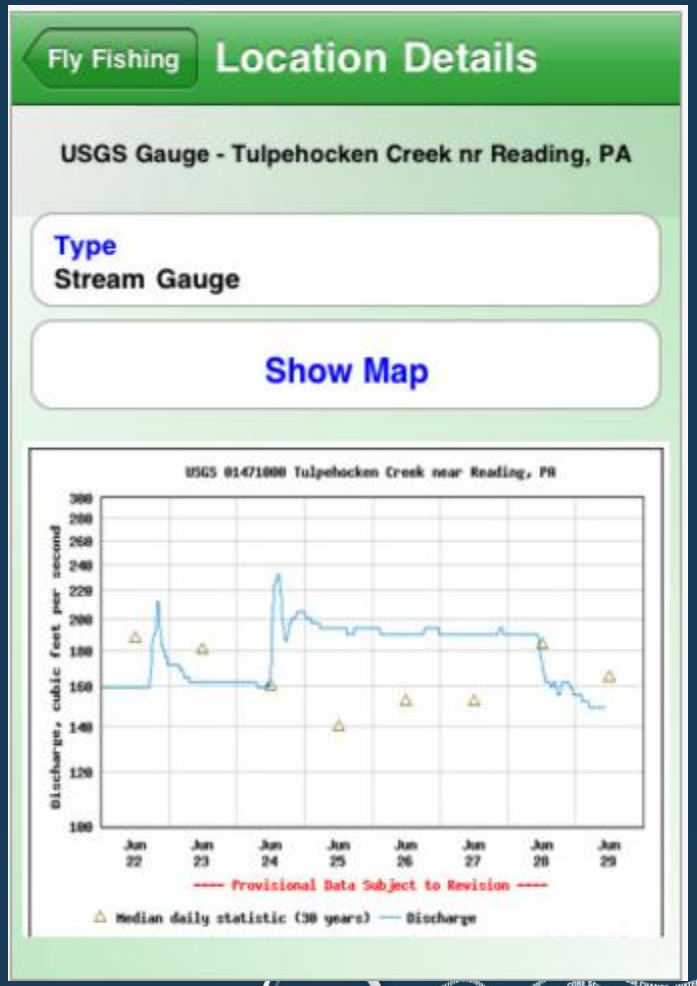
The Solution:
NWIS Web Services Snapshot

- **Retrieves and manages data from USGS NWIS Water Services**
- **Streamlines data retrieval and management for ArcMap users**
- **Educates end users on the NWIS database**
- **Serves as an example of a custom app that uses USGS web services – use our code (http://github.com/usgs) or build your own!**



Web Services

- We now have web services
- Allows one machine to talk to another
- Retrieve data more frequently
  - Instantaneous values
  - Daily values
  - Site data
  - Water-quality
- Ideal for custom built applications



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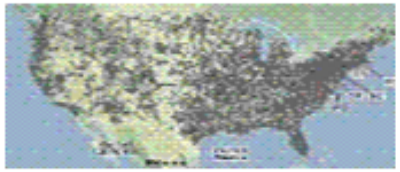


Map of all sites with links to all available water
individual sites.

Frequent Searches By Data Category

Groundwater Water levels in wells.

Water Quality Chemical and physical data for streams, lakes, springs, wells and other sites.

Internal Access Only See this section.

[NWISWeb Manual] [News] [FAQ] [NWIS-RT Home]

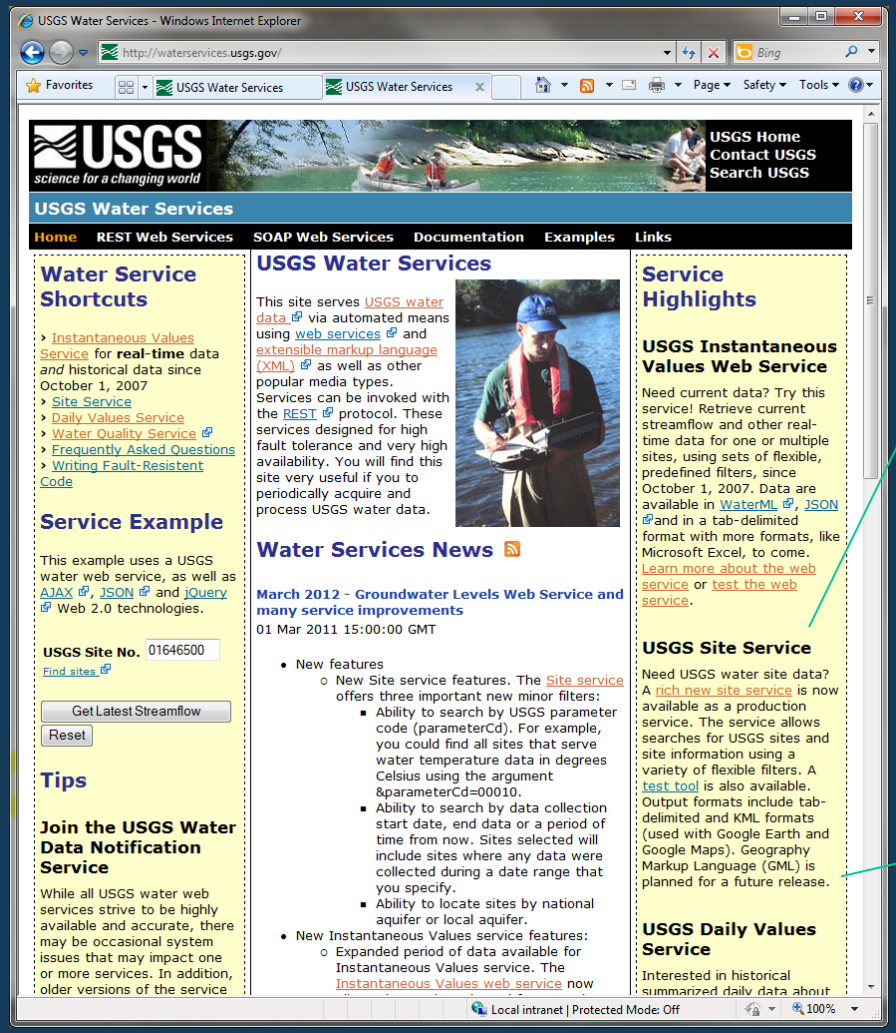
Questions about sites/data?
Feedback on this web site
Automated retrievals
Help

In the bottom left corner of almost every

http://waterdata.usgs.gov/nwis/news/?automated_retrieval_info

Send your programmer here to get started

Water Services

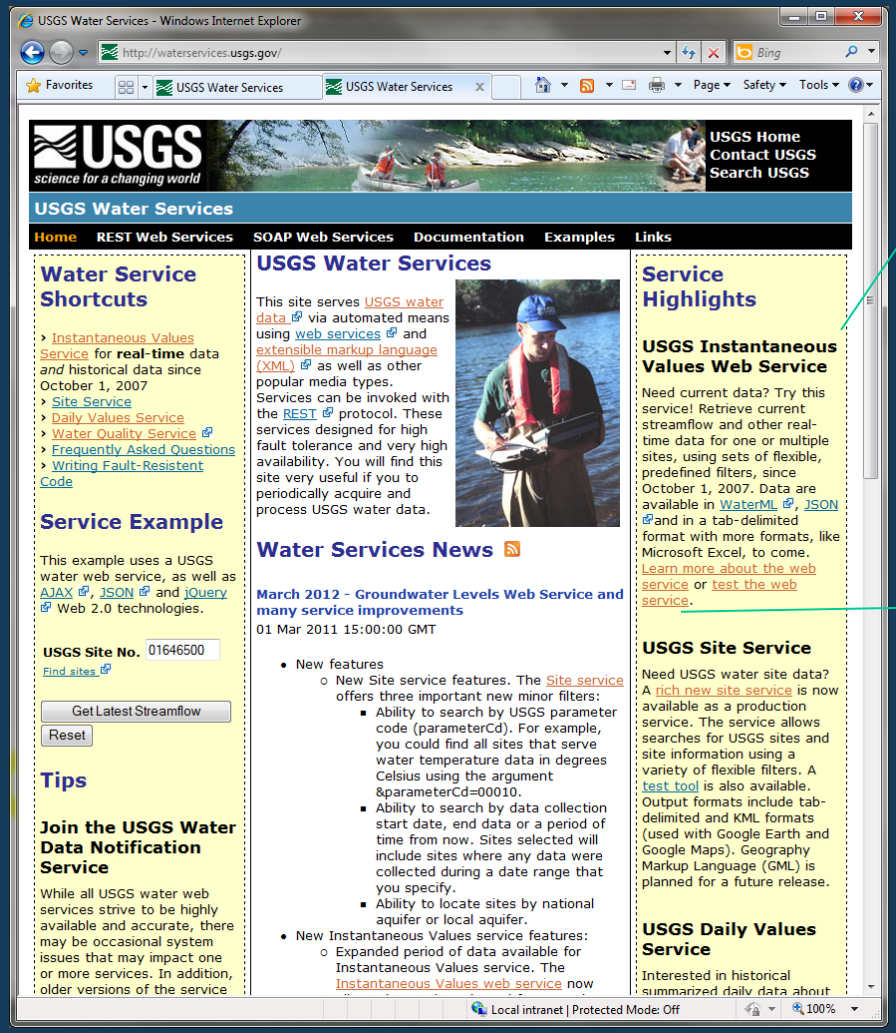


USGS Site Service

Need USGS water site data? A rich new site service is now available as a production service. The service allows searches for USGS sites and site information using a variety of flexible filters. A test tool is also available. Output formats include tab-delimited and KML formats (used with Google Earth and Google Maps). Geography Markup Language (GML) is planned for a future release.

http://waterservices.usgs.gov/

Water Services



USGS Instantaneous Values Web Service

Need current data? Try this service! Retrieve current streamflow and other real-time data for one or multiple sites, using sets of flexible, predefined filters, since October 1, 2007. Data are available in WaterML, JSON and in a tab-delimited format with more formats, like Microsoft Excel, to come. Learn more about the web service or test the web service.

http://waterservices.usgs.gov/

Water Services

USGS Daily Values Service

Interested in historical summarized daily data about our nation's streams, lakes and wells? This service provides a wealth of historical water data. Daily data available for USGS water sites include mean, median, maximum, minimum, and/or other derived values. Learn more and test the service.

http://waterservices.usgs.gov/

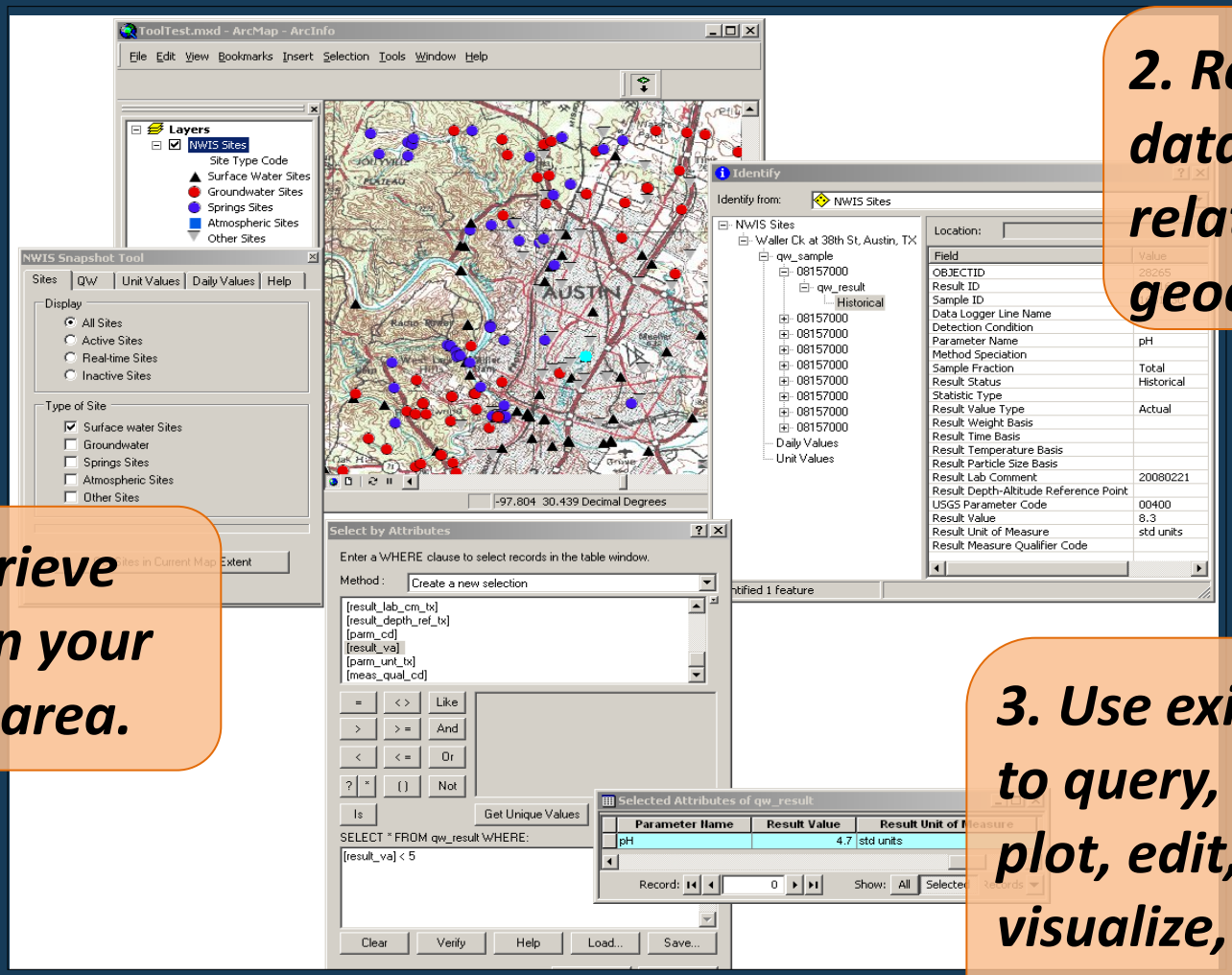
Water-Quality Web Services

- Download USGS and EPA data
- Compatible formats
- Most of the formatting has been done
- Still need to merge the files
- Released in April 2012

Water Quality Portal

http://www.waterqualitydata.us/

NWIS Web Services Snapshot



1. Retrieve sites in your study area.

2. Retrieve data to a relational geodatabase.

3. Use existing tools to query, analyze, plot, edit, expand, visualize, and export NWIS data.

System & Skill Requirements: Users

- Microsoft .NET Framework version 3.5
- ESRI ArcMap10.0
- Internet connection
- Assumes user is familiar with Microsoft Windows and ArcMap.

System Requirements: Developers

Minimum system requirements for working with the Snapshot source code:

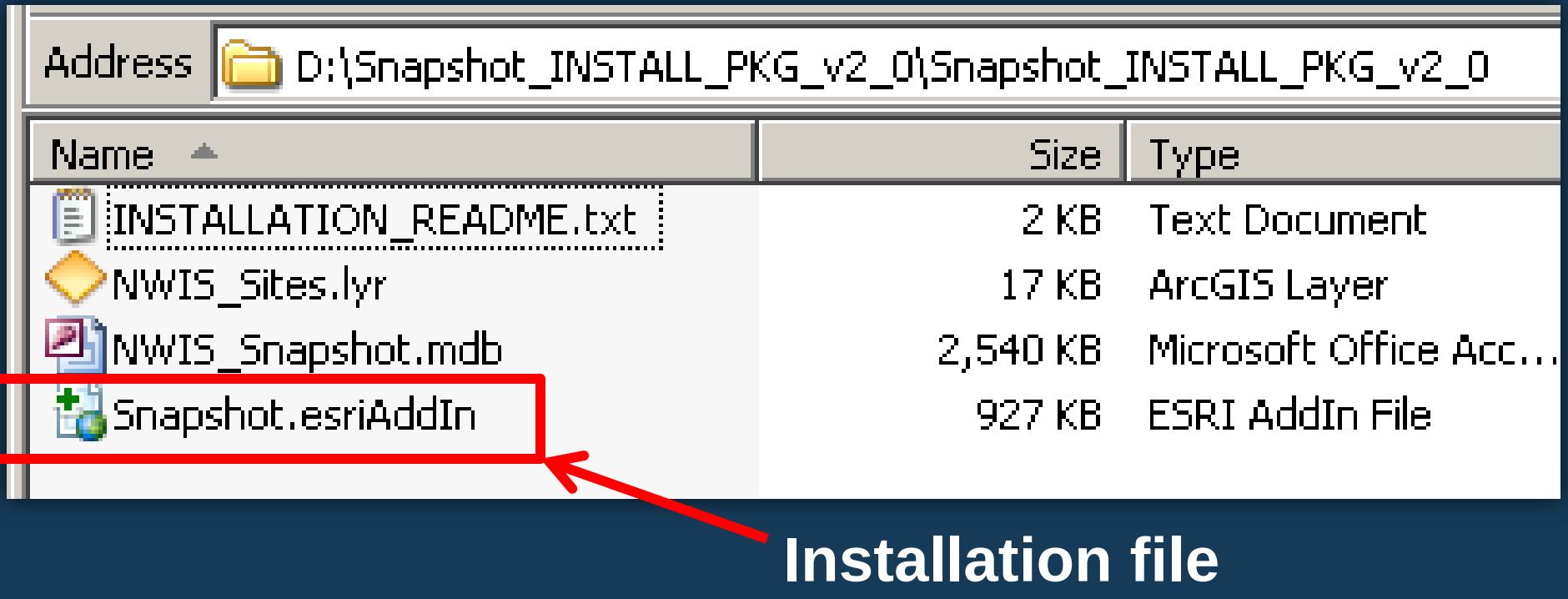
- Microsoft Visual Studio 2010
- .NET Framework 3.5
- ESRI ArcMap 10

Additional recommended resources (not required):

- ESRI SDK for ArcMap 10

Installation

- **Retrieve the install package from http://txpub.usgs.gov/snapshot**

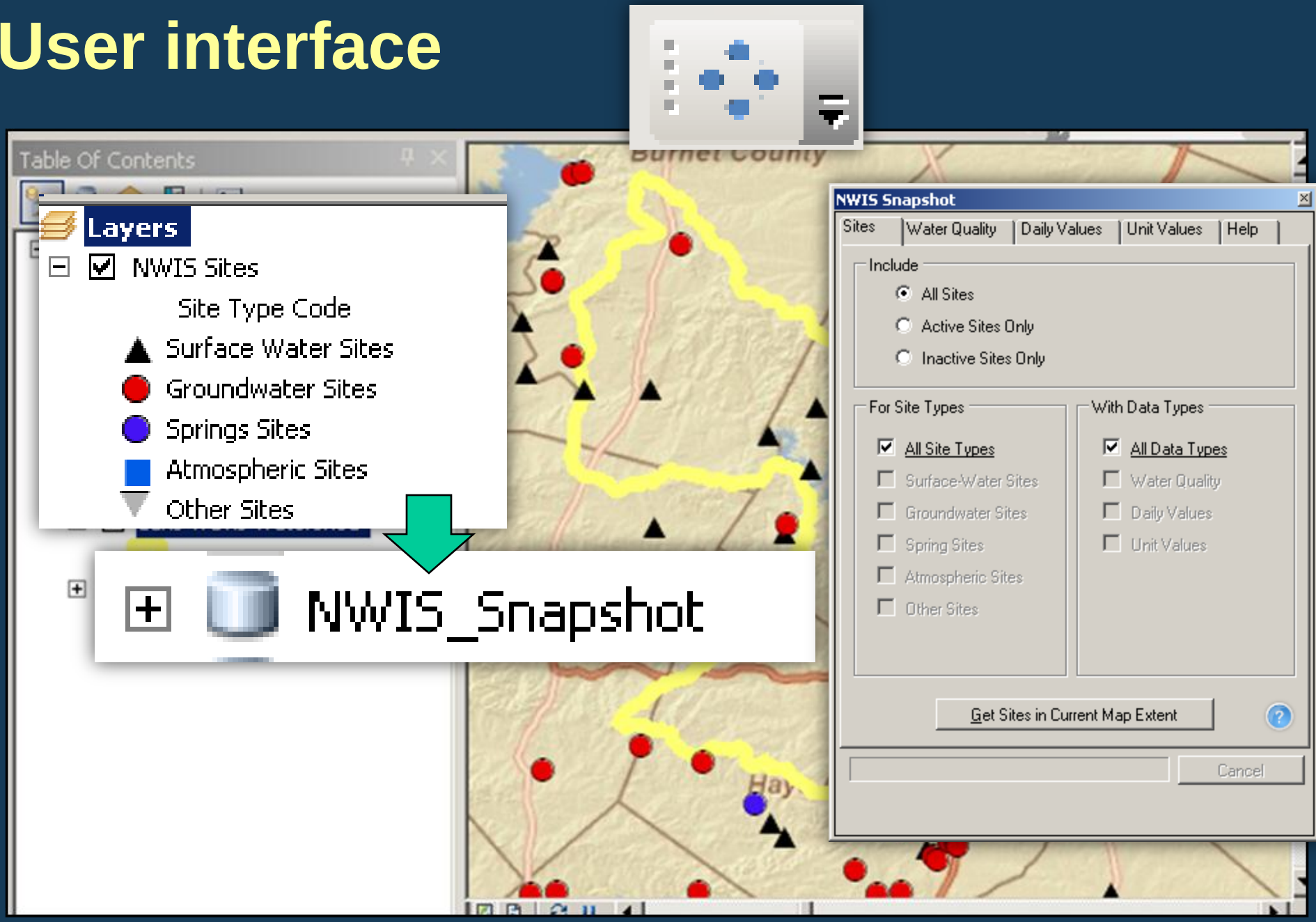


Installation

1. Save and unzip the installation .zip file anywhere on your computer
2. Double click the .esriAddIn installation file
   * System administrator rights are not needed
3. Add the NWIS_Sites.lyr file to ArcMap and connect it to the sitefile feature class

- Enterprise install option on a shared network drive through the Add-In Manager

User interface



Geodatabase Design

Populated by queries to http://www.waterqualitydata.us

WQ Samples

qw_sample	
I2	**SITENO**
FK1,I1	**record_no_xml**
	site_no_xml
	samp_type_nm
	medium_nm
	medium_sub_nm
	sample_start_dt
	sample_start_time
	sample_start_tz
	sample_end_dt
	samp_rel_depth_nm
	samp_depth_ref_tx
	project_cd
	coll_ent_nm
	sample_cm_tx
	aqfr_nm
	hyd_cond_nm
	hyd_event_nm
	result_count

WQ Results

qw_result	
I1	**record_no_xml**
	parm_cd
	dat_log_ln_nm
	remark_nm
	parm_alias_nm
	result_meth_spec_nm
	parm_frac_tx
	dqi_name
	parm_stat_tx
	result_val_tp
	parm_wt_tx
	parm_tm_tx
	parm_temp_tx
	parm_size_tx
	result_lab_cm_tx
	result_depth_ref_tx
	result_va
	parm_unt_tx
	meas_qual_cd

rel_qw_sample_result

rel_qw_site_sample

Site Information

sitefile	
FK1,FK2,FK3,I1	**SITENO**
	STNAME
	AGENCY
	SITE_TP_CD
	LAT
	LNG
	NWISWEB

Instantaneous Values

rel_site_uv

uv_result	
I1	**siteno**
	xml_param
	xml_date_and_time
	xml_qualifiers
	xml_value

Daily Values

rel_site_dv

dv_result	
I1	**siteno**
	xml_param
	xml_stat
	xml_date_and_time
	xml_qualifiers
	xml_value

Populated by queries to http://waterservices.usgs.gov

Data Request Log

Snapshot_DL_Date	
	OBJECTID
	Snapshot_Query
	Snapshot_Date

Water Quality Code Selection Tool

NWIS Snapshot

Sites | Water Quality | Daily Values | Unit Values | Help

Site Selection

- Request Data for All Sites
- Request Data for Selected Sites

Parameter Codes

00400

Selection Tool

Top Ten

All Parameter Codes

Count: 1

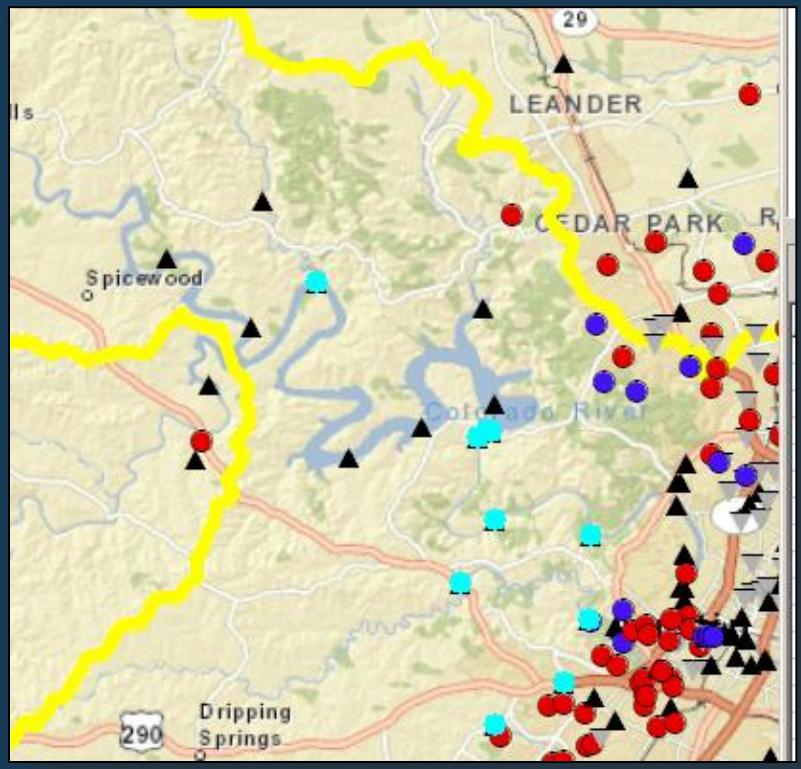
Date Range

Start Date: 6/ 4/2012

End Date: 6/ 6/2012

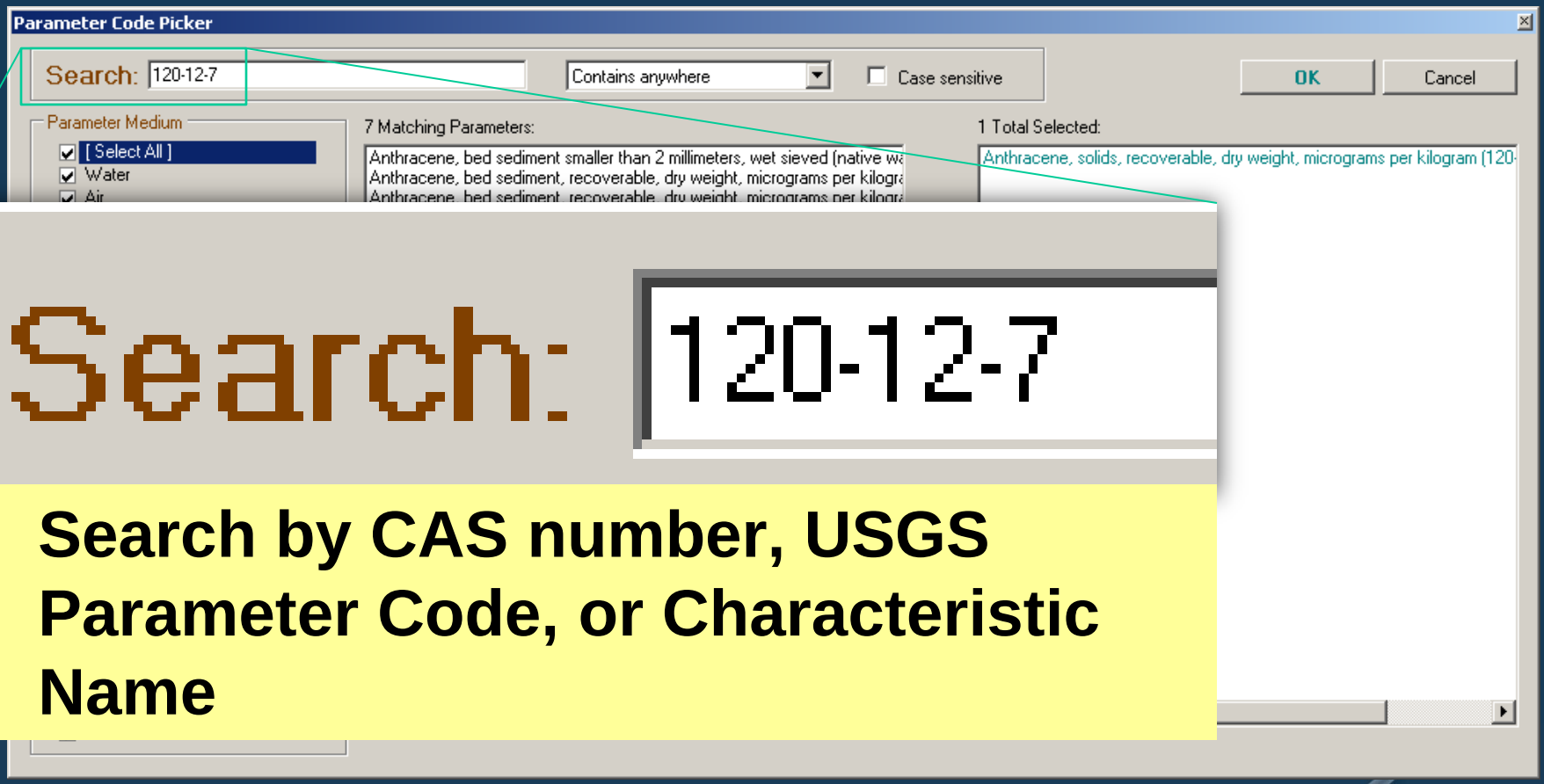
All Available for Period of Record

Get Water Quality Data



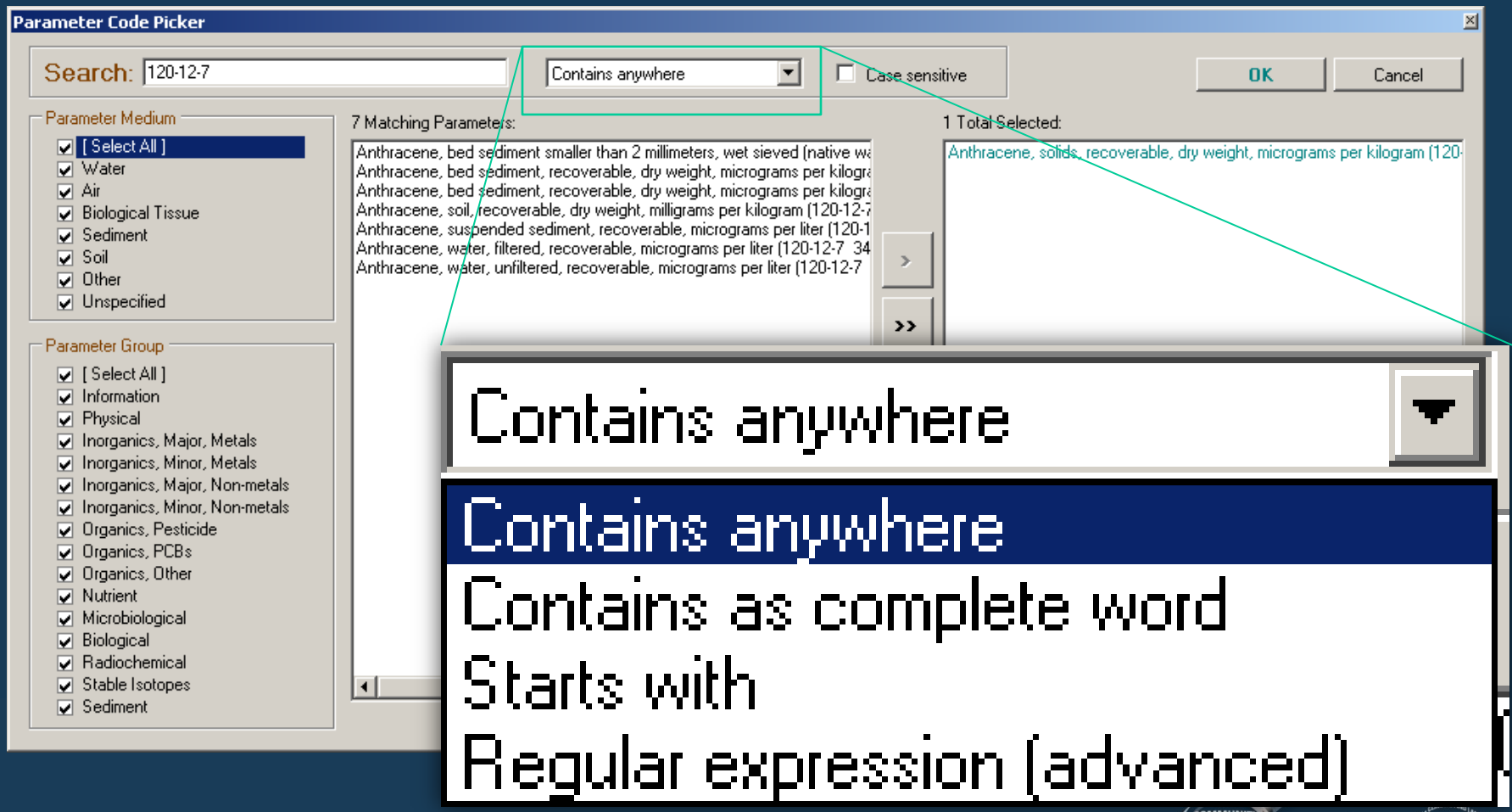
COMMUNITY FOR DATA INTEGRATION

Water Quality Code Selection Tool



Search by CAS number, USGS Parameter Code, or Characteristic Name

Water Quality Code Selection Tool

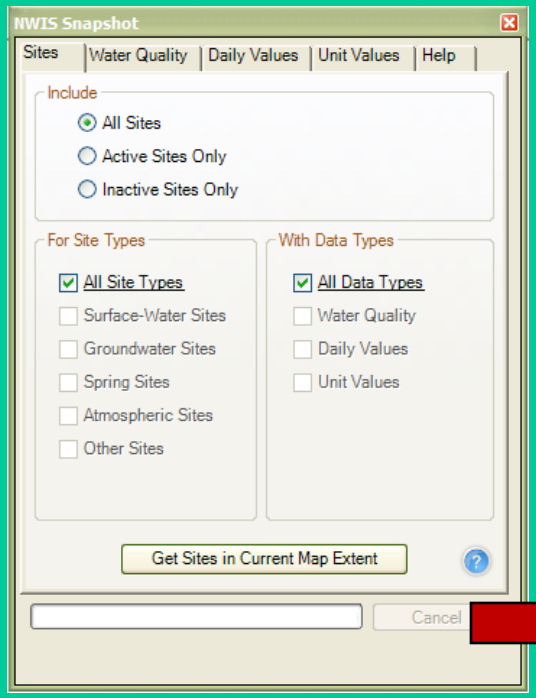


The Snapshot Workflow

1. Interface options determine URL for querying web service

2. Web service returns XML data stream of matching results

3. XML is parsed, geodatabase populated, and map refreshed

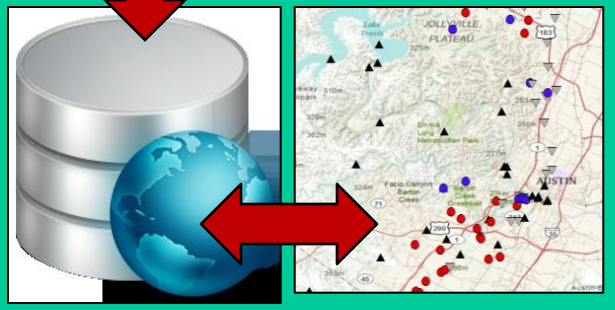



```
<?xml version="1.0" encoding="UTF-8" ?>
  <mapper>
    <sites>
      <site sno="02479965" sna="BIG CREEK
      <site sno="02479960" sna="LONGHOR
      <site sno="02479975" sna="LITTLE JAS
      <site sno="02479975" sna="COLD RUN
      <site sno="02479975" sna="BULL MOO
```

WEB SERVICE

waterservices.usgs.gov

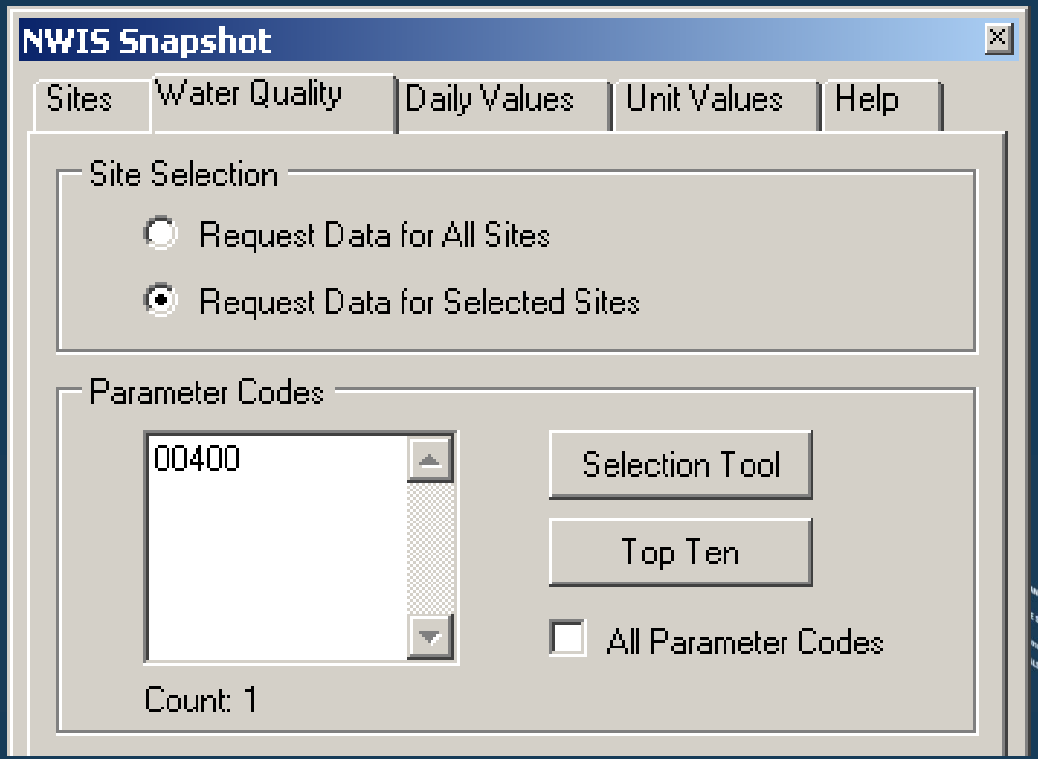
```
http://waterservices.usgs.gov/nwis
/site?format=mapper,1.0&bBox=83.0,
36.5,81.0,38.5&siteStatus=active..
```



Geodatabase ↔ Sites Layer Linking

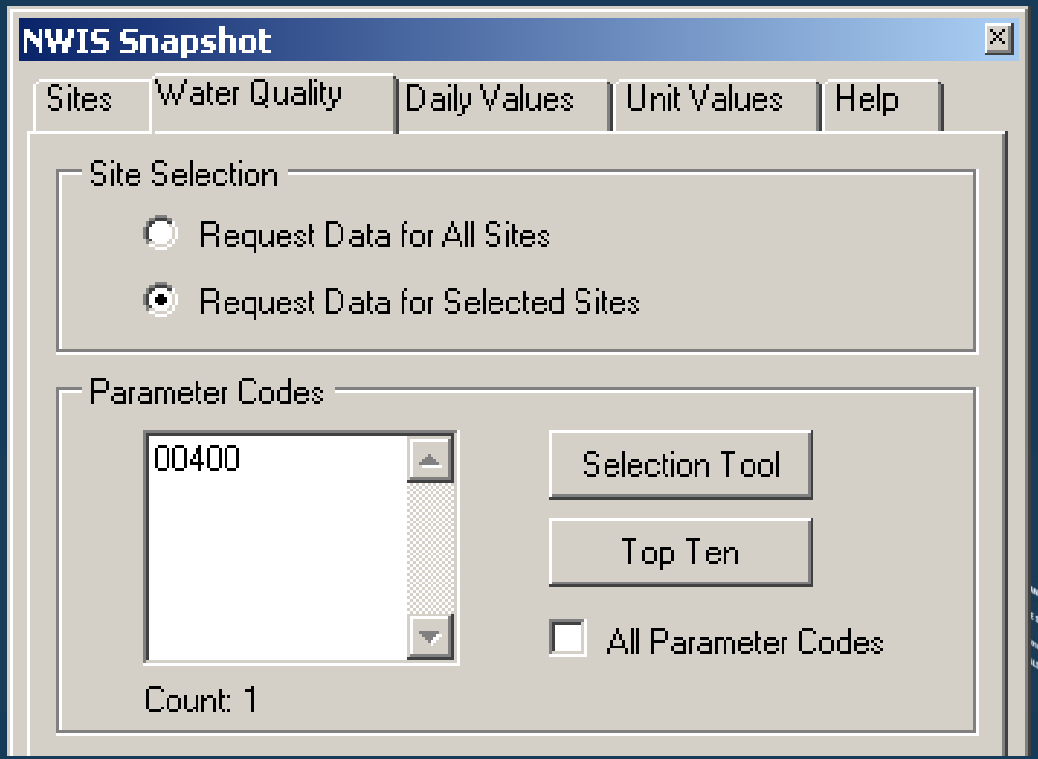
Requesting data from a web service

http://www.waterqualitydata.us/Result/search?siteid=USGS-06832500&pCode=00400&mimeType=xml



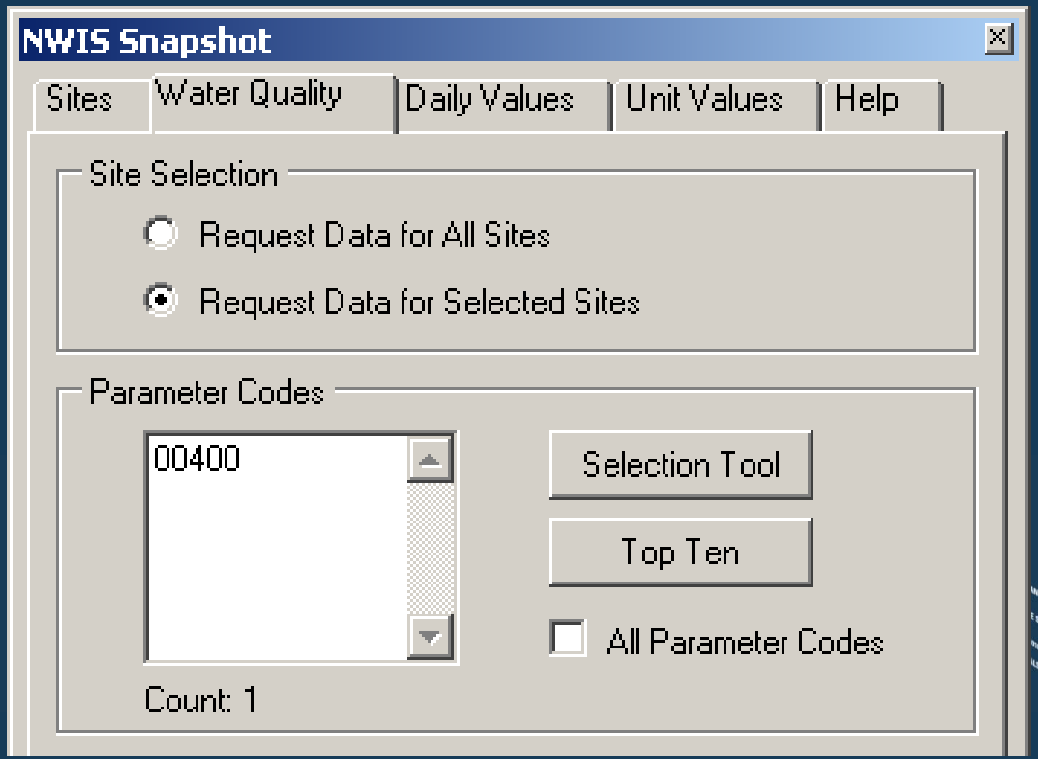
Requesting data from a web service

http://www.waterqualitydata.us/Result/search?siteid=USGS-06832500&pCode=00400&mimeType=xml

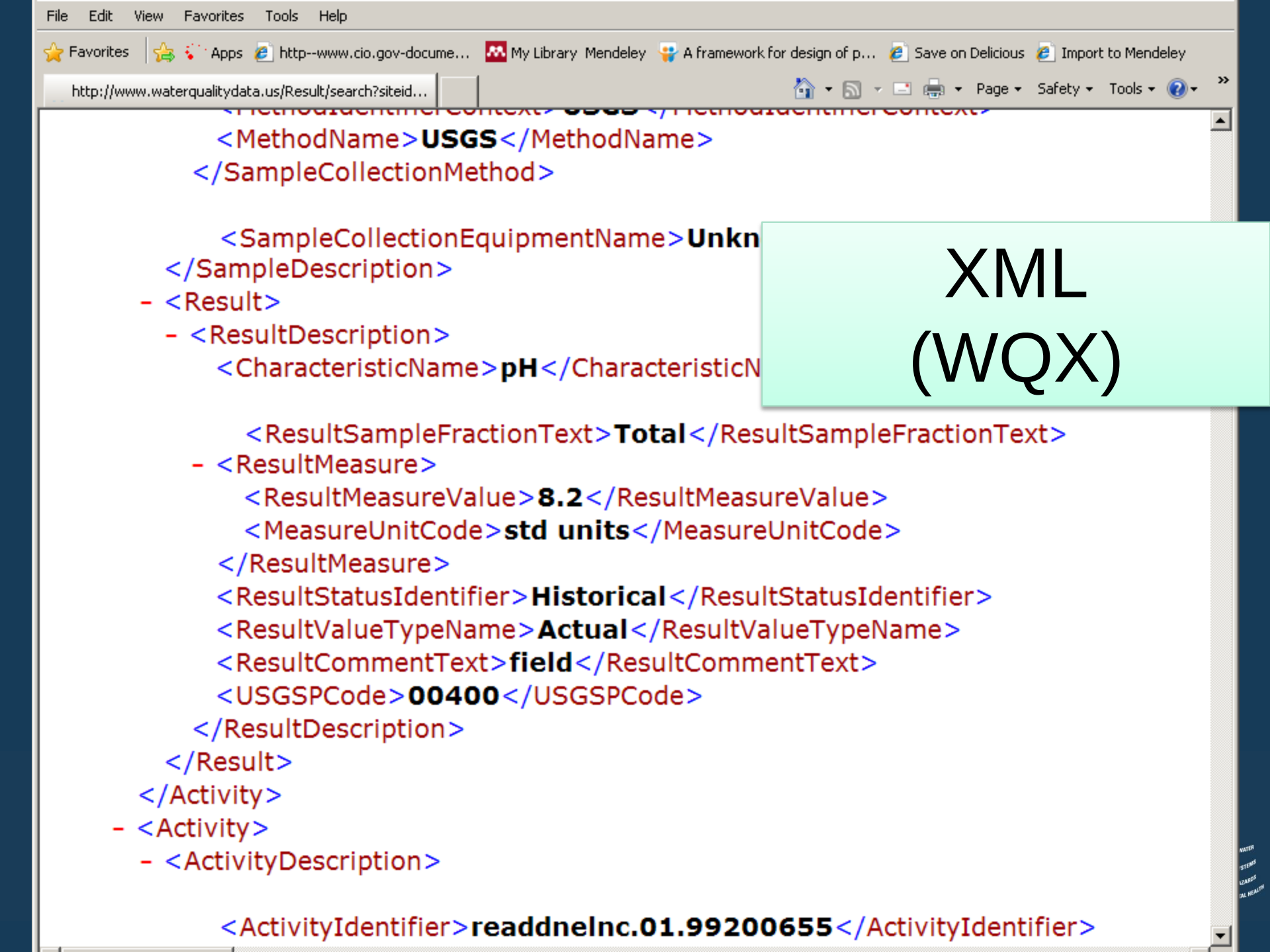


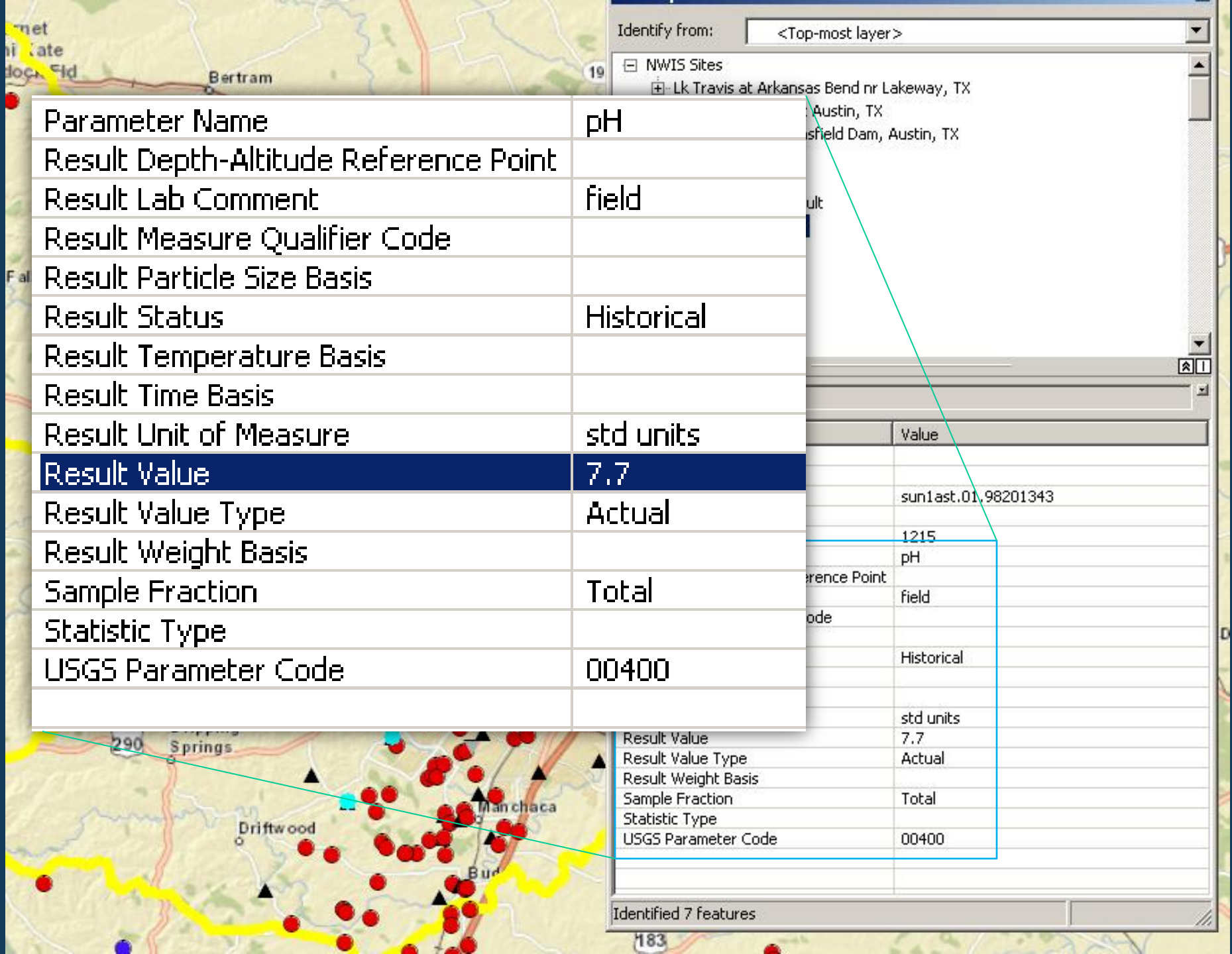
Requesting data from a web service

http://www.waterqualitydata.us/Result/search?siteid=USGS-06832500&pCode=00400&mimeType=xml



USGS


File Edit View Favorites Tools Help
Favorites Apps http--www.cio.gov-docume... My Library Mendeley A framework for design of p... Save on Delicious Import to Mendeley
http://www.waterqualitydata.us/Result/search?siteid...
Page Safety Tools
<MethodName>USGS</MethodName>
</SampleCollectionMethod>
<SampleCollectionEquipmentName>Unkn
</SampleDescription>
- <Result>
- <ResultDescription>
<CharacteristicName>pH</CharacteristicN
<ResultSampleFractionText>Total</ResultSampleFractionText>
- <ResultMeasure>
<ResultMeasureValue>8.2</ResultMeasureValue>
<MeasureUnitCode>std units</MeasureUnitCode>
</ResultMeasure>
<ResultStatusIdentifier>Historical</ResultStatusIdentifier>
<ResultValueTypeName>Actual</ResultValueTypeName>
<ResultCommentText>field</ResultCommentText>
<USGSPCode>00400</USGSPCode>
</ResultDescription>
</Result>
</Activity>
- <Activity>
- <ActivityDescription>
<ActivityIdentifier>readdnelnc.01.99200655</ActivityIdentifier>
XML
(WQX)

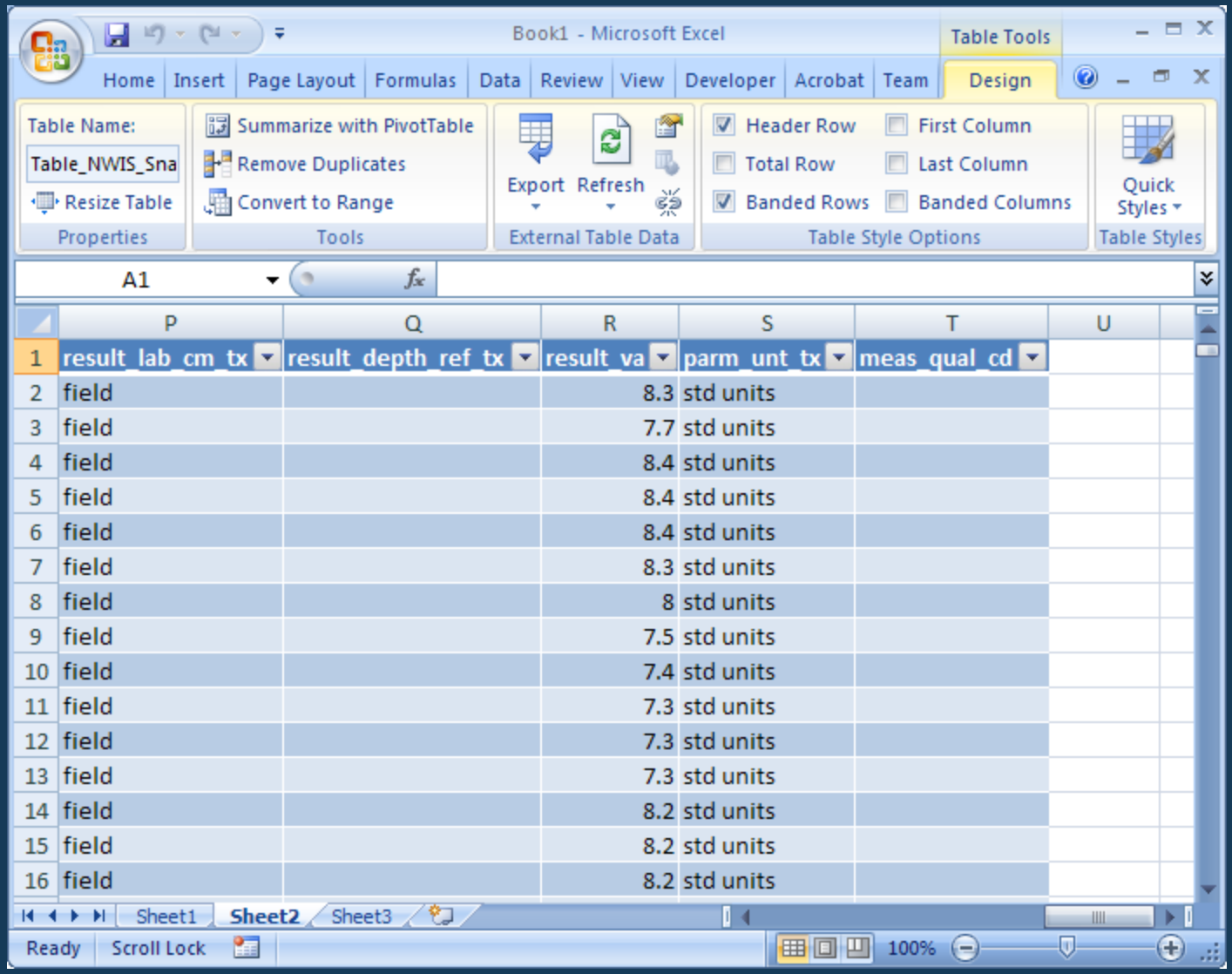


Parameter Name	pH
Result Depth-Altitude Reference Point	
Result Lab Comment	field
Result Measure Qualifier Code	
Result Particle Size Basis	
Result Status	Historical
Result Temperature Basis	
Result Time Basis	
Result Unit of Measure	std units
Result Value	7.7
Result Value Type	Actual
Result Weight Basis	
Sample Fraction	Total
Statistic Type	
USGS Parameter Code	00400

Demonstration

- Retrieving site information and daily values
  - http://txpub.usgs.gov/snapshot/Video/NHPSiteDV.swf
- Retrieving and querying water quality information
  - http://txpub.usgs.gov/snapshot/Video/NHPWaterQuality.swf
- Animating gage data
  - http://txpub.usgs.gov/snapshot/video/NHPAnimation.swf

Geodatabase is useable in Excel, Access, R, & Matlab



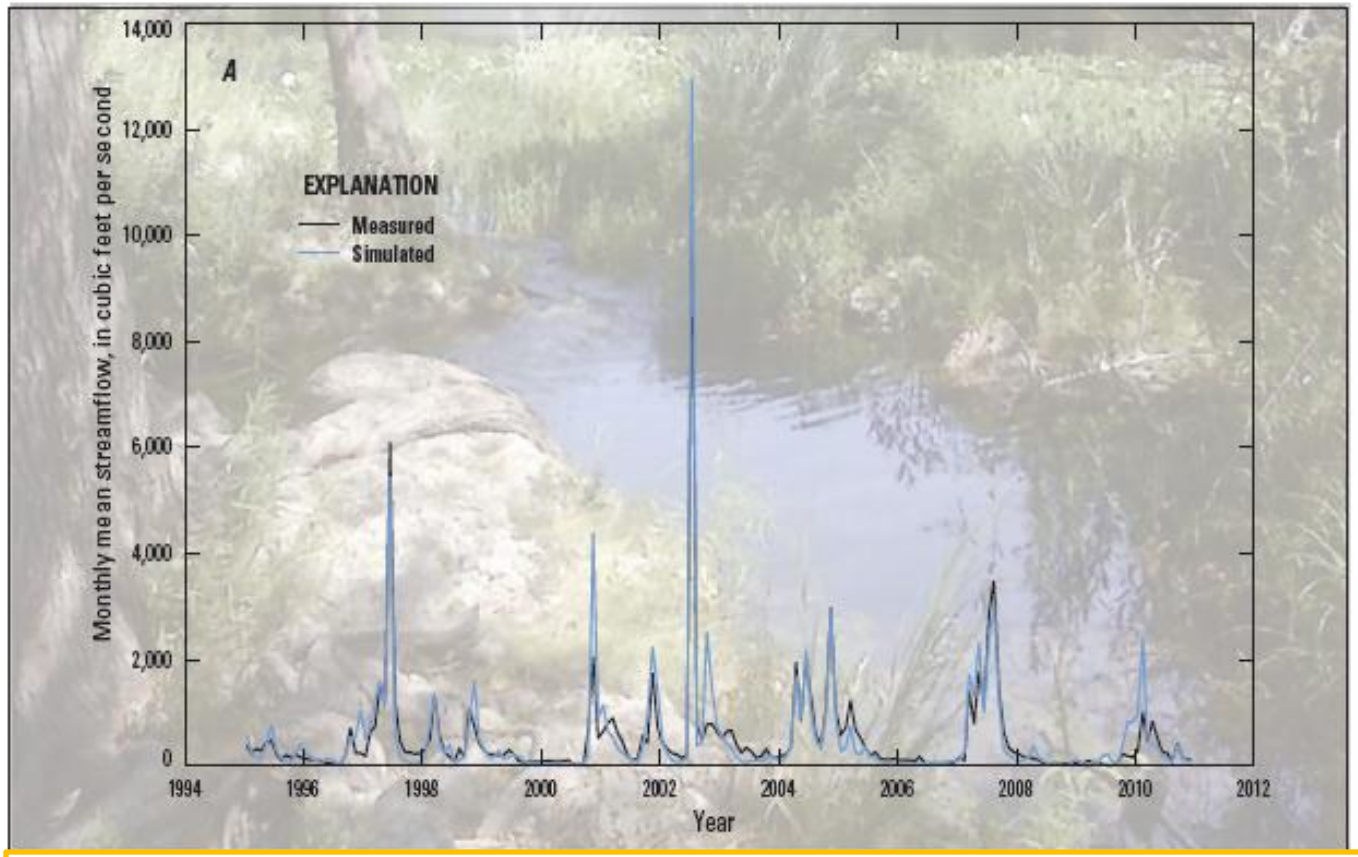
	P	Q	R	S	T	U
1	result_lab_cm_tx	result_depth_ref_tx	result_va	parm_unt_tx	meas_qual_cd	
2	field		8.3	std units		
3	field		7.7	std units		
4	field		8.4	std units		
5	field		8.4	std units		
6	field		8.4	std units		
7	field		8.3	std units		
8	field		8	std units		
9	field		7.5	std units		
10	field		7.4	std units		
11	field		7.3	std units		
12	field		7.3	std units		
13	field		7.3	std units		
14	field		8.2	std units		
15	field		8.2	std units		
16	field		8.2	std units		

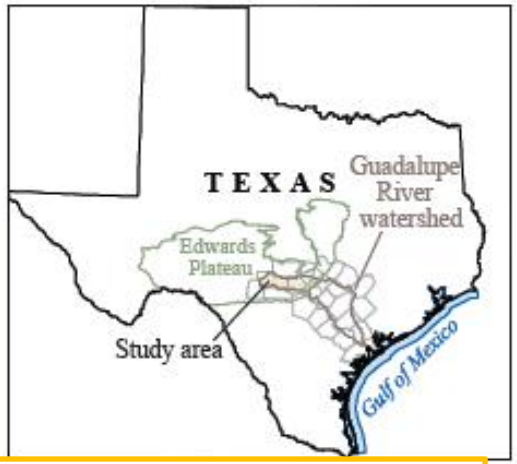
FY12: Public Release

- Education
  - UT Austin “GIS in Water Resources”
  - ACC GIS Course
- Citizen Science
  - Ipswich community watershed group
- USGS Projects
  - SPARROW model validation in the Gulf region
  - High Plains groundwater flow model
  - Upper Guadalupe brush management

User Story: Modelling the Effects of Brush Management

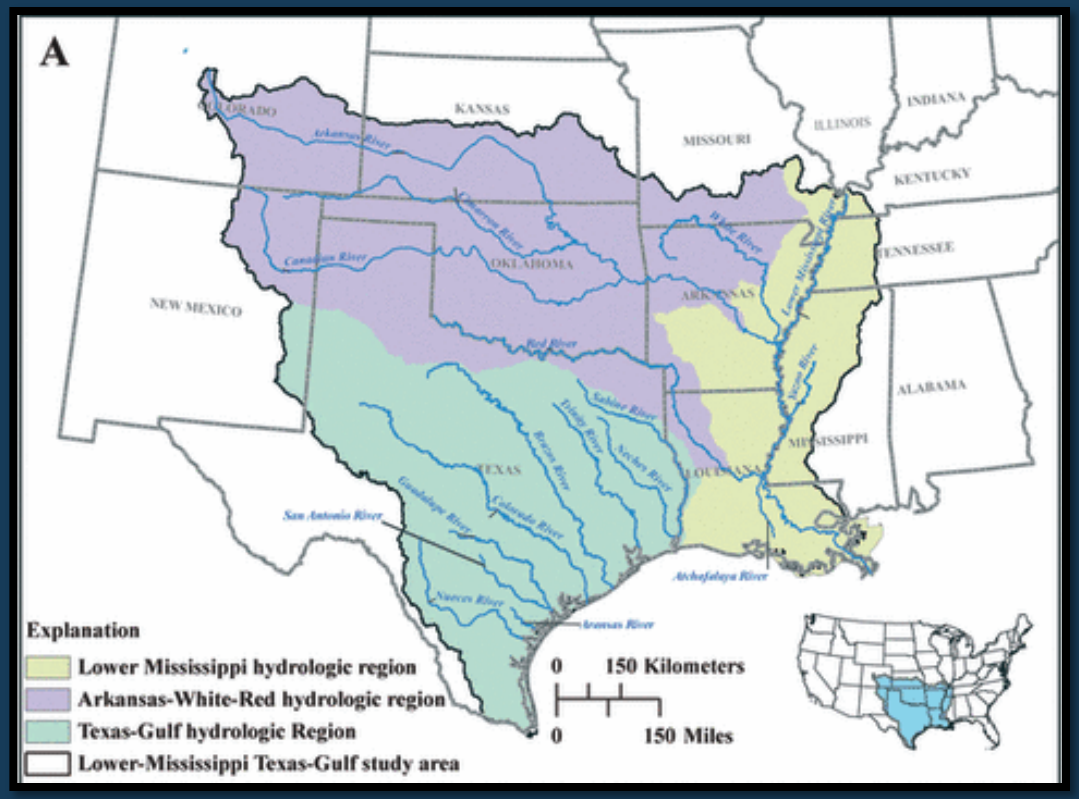
The Snapshot Tool enabled rapid retrieval of 15 years of daily streamflow measured at a gage along the upper Guadalupe River. The measured streamflow was used to calibrate a Soil Water Assessment Tool (SWAT) model of the watershed. Resource managers are using the study results to guide brush management practices for the purpose of increasing water yields *(Bumgarner and Thompson, 2012)*.





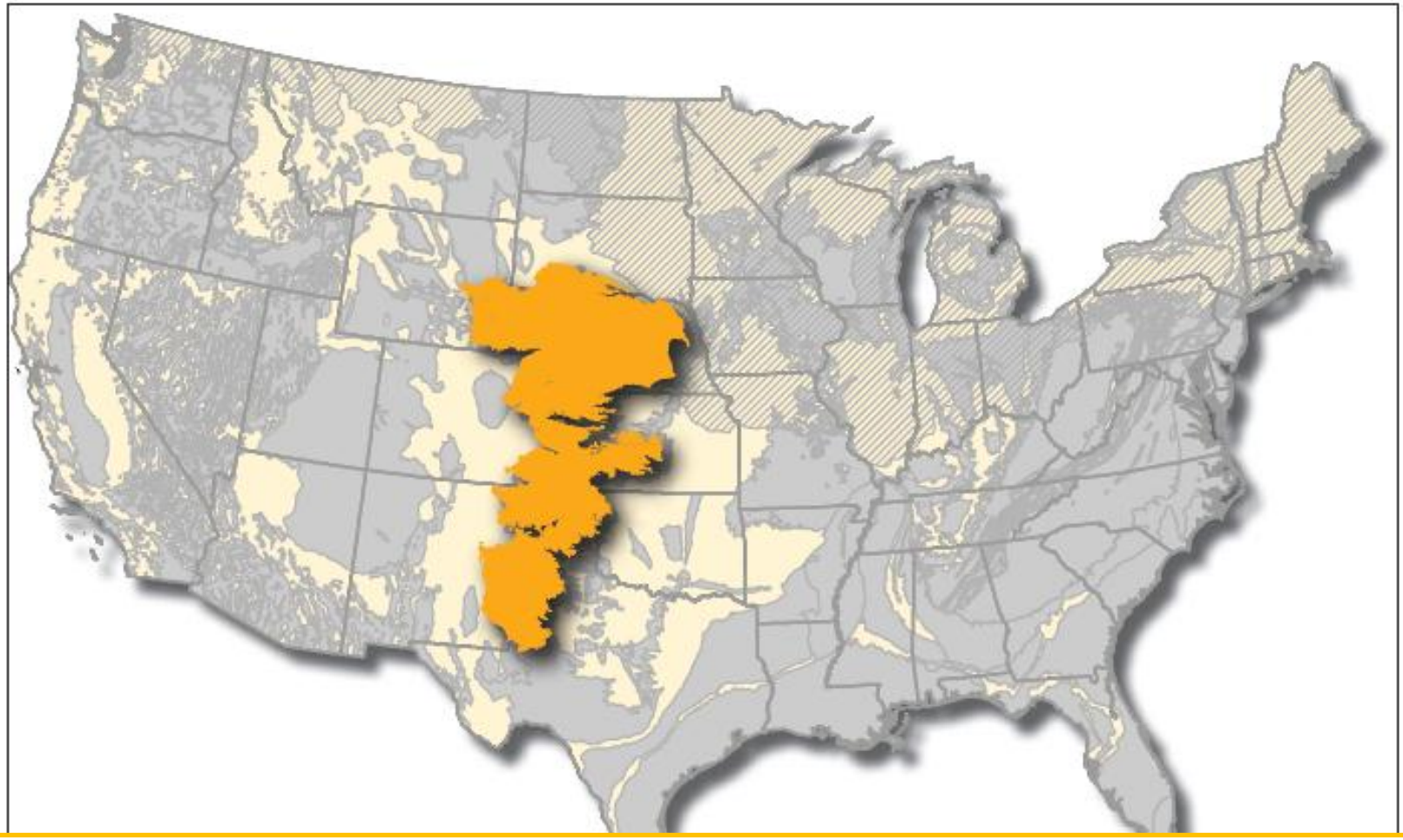
Bumgarner, J.R., and Thompson, F.E., 2012, *Simulation of streamflow and the effects of brush management on water yields in the upper Guadalupe River watershed, south-central Texas, 1995–2010*: **USGS SIR 2012–5051**, 25 p.

Water quality data for SPARROW model validation



- Major River Basin (MRB) region 5
- Prediction of nutrient loads and yields to the Gulf of Mexico in monitored and unmonitored streams

User Story: Quantifying Groundwater Availability



Daily groundwater levels from NWIS augmented the *High Plains Aquifer Water-Level Monitoring Study* data. Selected levels are being used to calibrate the Northern High Plains Aquifer groundwater flow model (*http://txpub.usgs.gov/HPWA*).

The Future

- Use the new USGS Groundwater Levels Web Service

Groundwater Site Types

- Well
  - Collector or Ranney type well
  - Extensometer well
  - Hyporheic-zone well
  - Interconnected wells
  - Multiple wells
  - Test hole

Agency Code:

Minimum site altitude in feet:

Maximum site altitude in feet:

Well has a minimum depth in feet of:

Well has a maximum depth in feet of:

Hole has a minimum depth in feet of:

Hole has a maximum depth in feet of:

Sites contained within these national aquifer codes:

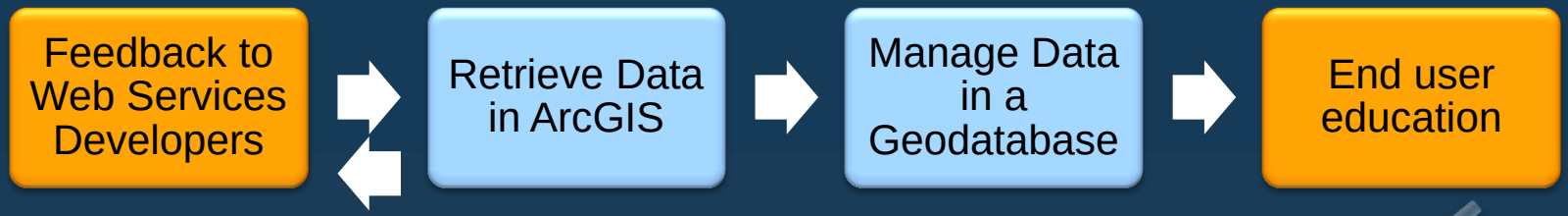
Sites contained within these local aquifer codes:

The Future

- Transform to a web-based application
- Inclusion on the Geospatial Platform
- Retrieve EPA Storet data
- Potential integration with National Atlas stream tracer web application
- Improve water quality parameter search with ontology experts
- Leverage EGRET data analysis R package to work with data in the Snapshot geodatabase
- Standards-compliant metadata generation

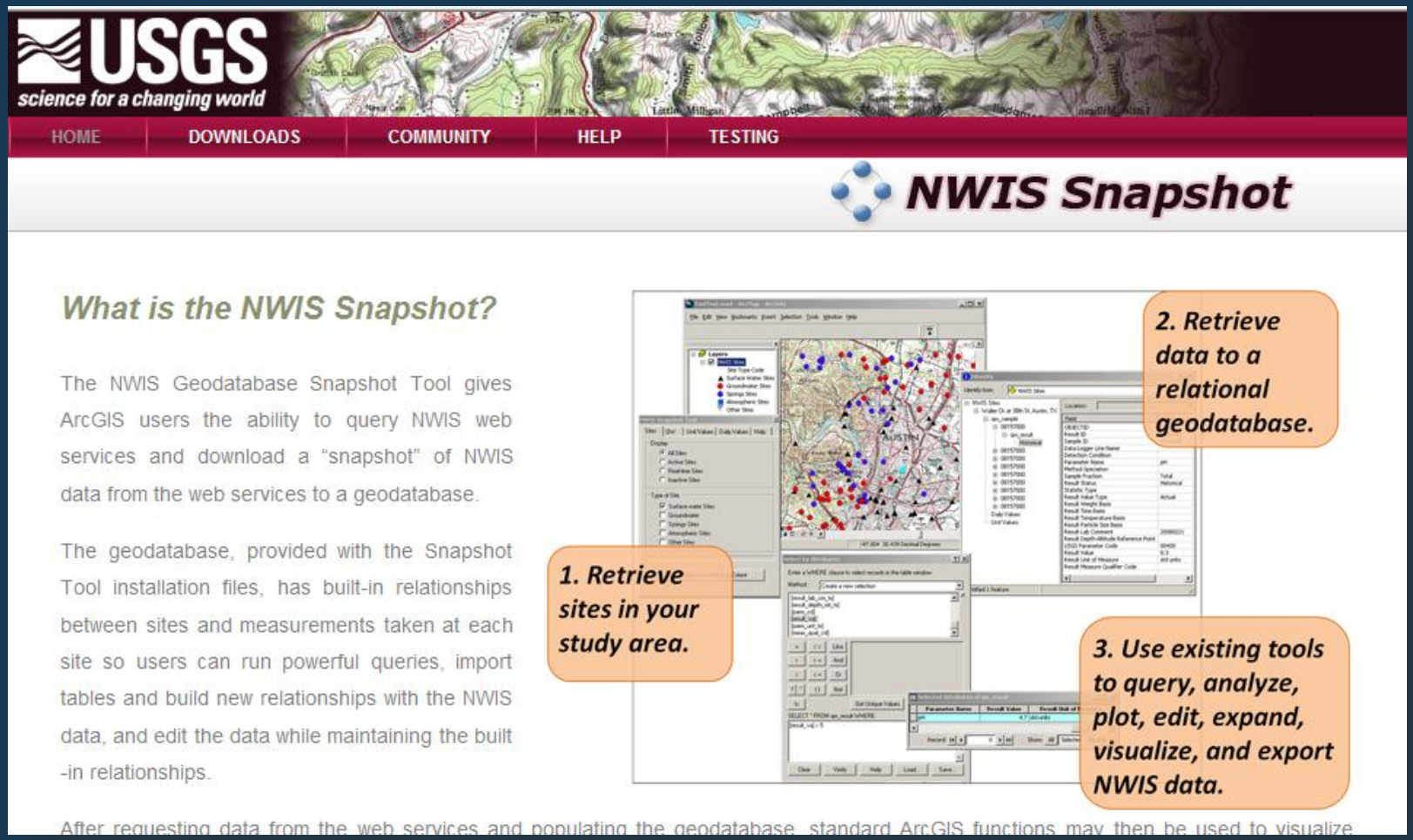
NWIS Web Services Snapshot for ArcGIS

- Streamlines water **data retrieval** and **management** for USGS and public ArcMap users
- Educates end users about the NWIS database
- Serves as an example of a custom app that uses USGS web services (Source code: http://github.com/usgs)



Where to get the software and code

http://txpub.usgs.gov/snapshot



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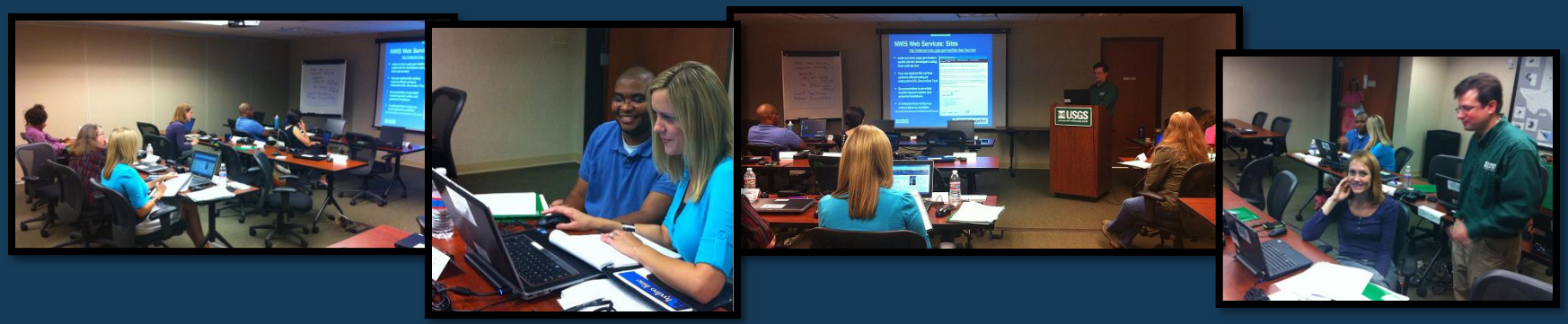

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http://txpub.usgs.gov/snapshot